Updates and Advanced Therapies for Gastrointestinal Stasis in Rabbits

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KEYWORDS

• Rabbit • Gastric stasis • Fluid therapy

UNDERSTANDING GASTROINTESTINAL STASIS IN RABBITS

Gastrointestinal stasis is currently a vaguely defined term for decreased gastrointestinal motility. The term gastric stasis syndrome was previously proposed,[1] but falls short of an accurate description, as in many cases portions of the gastrointestinal tract other than the stomach are affected. Capello has recently proposed the term rabbit gastrointestinal syndrome (RGIS) to define a complex of clinical signs, symptoms, and concurrent pathologic conditions affecting the digestive apparatus of the rabbit. The following pathologic conditions can be included, and often occur in combination:

Gastric impaction
Gastric gas accumulation
Intestinal impaction
Intestinal gas accumulation
Intestinal obstruction
Primary gastroenteritis
Adhesions
Neoplasia
Pancreatitis
Liver disease (hepatic lipidosis, torsion, cholangiohepatitis).

In many cases, underlying cause of RGIS is uncertain. Symptoms may be secondary to any disease producing alterations in fluid balance (dehydration/shock) and/or alterations in gastrointestinal motility. Lichtenberger has recognized RGIS associated with nonspecific hepatitis and pancreatitis confirmed histopathologically,

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and in some cases suspected at ultrasound. It should also be noted that psychogenic stress is well defined in terms of negative impact on gastrointestinal motility.[2]

Impaction can be produced by overaccumulation of normal gastrointestinal contents due to alterations in motility, or desiccation of normal contents due to dehydration. Impaction of various portions of the gastrointestinal tract with foreign material has also been reported.[3]

In terms of gastrointestinal obstruction, it is noteworthy that true gastric (pyloric) obstruction is uncommonly reported in clinical practice. However, a 2006 study of postmortem findings in Angora rabbits reported a death rate of 28.6% over a 5-year period, which the investigators attributed to the presence of a large, firm trichobezoar in the pyloric region of the stomach.[4] Most cases of true obstruction in pet rabbits are reported to occur in the proximal duodenum, or the ileocecolic junction.[5] Other sites of lower gastrointestinal obstruction have been described as well, including cases of multiple obstructions (Capello, personal communication, December 2009) The most commonly reported cause of obstruction is tightly packed hair; other less commonly mentioned objects include carpet fibers and locust bean seeds.[5] Harcourt-Brown[5] has also described intestinal obstruction secondary to herniation, and tapeworm cysts. In all cases, obstruction can be complete or partial; in many cases absolute diagnosis is difficult.

Malnutrition and alterations in diet are often implicated in cases of RGIS and include low-fiber diets, excess carbohydrates, and rapid diet change.[1] The fiber requirements of rabbits are well described. Increased carbohydrate consumption can produce disruption of motility, leading to alterations in the cecal pH and disruption of the complex bacterial flora of the hindgut.[1]

Primary gastroenteritis (bacterial, viral, parasitic) is uncommon, and full discussion is beyond the scope of this article.

Clinical symptoms of RGIS vary in severity and can include depression, reluctance to move, teeth grinding, abnormal posture suggestive of abdominal discomfort, reduced food intake to anorexia, reduced to absent stool production or abnormal stool character, and presence of excessive or uneaten cecotrophs.

Physical examination findings in cases of RGIS can be unremarkable but also can include fluid imbalances (dehydration, shock), abdominal distention, including gastric and intestinal distension, and gastric tympany. Other symptoms may be related to ongoing underlying conditions. Severely ill rabbits in hypovolemic shock are often hypothermic, with pale mucus membranes and decreased capillary refill time, and altered mentation (depressed to comatose). Indirect blood pressure is low or unobtainable.[6]

When ill rabbits present for examination it is important to determine if RGIS is present and if so, begin treatment and a diagnostic workup to determine underlying contributing factors. Identification of underlying cause is often difficult; the authors and others have encountered many rabbits presenting with evidence of RGIS whereby attempts to identify an underlying cause are unfruitful. In many cases, these patients respond positively to supportive therapy including fluids, hand feeding, and motility-enhancing drugs.

INITIAL PRESENTATION AND EVALUATION: DECISION-MAKING

All ill rabbits are evaluated as quickly as possible.

Decision 1

Can this rabbit tolerate manual restraint, evaluation, and treatment?

Most pet rabbits tolerate handling well. However, in some severely ill or stressed patients, handling and treatment may worsen clinical condition. Delay of treatment

carries risk as well. For these cases, the authors highly recommend sedation.[7] Sedation is an underutilized option for ill rabbits. Benefits are multiple and include reduction of anxiety and stress, as well as relief of pain. Relief of pain is of particular benefit, as many diseases of rabbits produce discomfort to at least some degree. The authors recommend midazolam (Baxter Healthcare Corp, Deerfield, IL, USA) in combination with an opioid analgesic.

Midazolam At sedation doses, this drug has a wide margin of safety in humans and many species, and clinical experience has revealed the same in rabbits. Dosages are reduced further when combined with an opioid, and when used in ill or debilitated patients.[8] Dosages are listed in **Table 1**.

Opioids At lower doses, these drugs are generally safe in many species, and are reversible. Butorphanol (Dolorex; Intervet, Millboro, DE, USA), buprenorphine (Buprenex; Reckitt Benckiser, Richmond, VA, USA), and others are commonly used by the authors and others as analgesics for rabbits.[9] For ill rabbits, select shorter-acting drugs with a lower dose range and combine with midazolam.

There is considerable debate over the use of opioids in rabbits with decreased gastrointestinal motility, as these drugs can produce dose-dependent reduction of motility in humans and other species.[10] As most gastrointestinal disease is painful, and pain and distress are potent depressors of gastrointestinal motility, the authors and others believe that the use of opioids are fully justified when used with appropriate measures to support the gastrointestinal tract (eg, fluids and motility-enhancing drugs).

Table 1
Drugs mentioned in this article for use in treatment of rabbits with suspected gastrointestinal disease

Drug	Dosage	Comments
Midazolam	0.25–0.25 mg/kg IV, IM, SC	For sedation; use lower dosages in ill rabbits; synergistic when combined with an opioid
Butorphanol	0.20–0.4 mg/kg IM	For analgesia, and sedation when combined with midazolam
Hydromorphone	0.10 mg/kg IM	For more severe pain; use in combination with midazolam for added sedation
Cisapride	0.5 mg/kg every 8 h PO	Oral solution available through compounding pharmacies
Ranitidine	0.5 mg/kg every 24 h IV or SC	May be synergistic with cisapride
Trimebutine		Motility regulator Not available in the USA but may be legally imported by veterinarians for personal use
Fentanyl/ketamine constant rate infusion	Fentanyl = 5–10 μg/kg/min + ketamine = 1–2 mg/kg/h	Added to crystalloid fluids at rates appropriate for correction of fluid deficits and/or maintenance. Drugs are added to fluids or placed in a syringe pump to provide hourly dosage

Dosages/rates for fluid support are given in the text.

Thorough physical examination should proceed carefully, with attention to changes in condition.

Decision 2

What type of fluid support is indicated?

As gastrointestinal motility is affected by patient hydration, and RGIS negatively impacts hydration, all patients with signs or symptoms suggestive of RGIS should receive fluids.[11]

Guidelines for fluid type and rate determination are presented in the section on fluid administration. In general, subcutaneous fluids are only appropriate for those stable patients with normal hydration to mild dehydration.[6] Oral fluid replacement is only appropriate when obstruction is unlikely and the gastrointestinal tract is judged to be functional. Replacement needs are calculated as described below, and administered in subcutaneous boluses, or per os as applicable. Moderately dehydrated rabbits, or those showing evidence of shock require direct vascular support.[6] Options include intravenous (cephalic, lateral saphenous, auricular vessels) or intraosseous access (femur, tibia).[12] Although intraosseous access is not technically considered direct vascular access, functionally it is equivalent to intravenous access.[13]

Placement of an intravenous catheter is straightforward and is greatly facilitated by sedation, as described above, with topical anesthesia of the venipuncture site. Topical anesthesia helps to reduce sudden pullback of the limb at the moment of skin penetration. The site is prepared and lidocaine gel applied to the skin. After 5 to 10 minutes roll the skin away from the vein and inject lidocaine into the dermis and subcutis. It is important to wait an additional 5 to 10 minutes to allow the drug to take effect. Choose a 24- to 25-gauge catheter. Note that intact male rabbits often have particularly tough skin that complicates catheterization. For these patients, gently roll the skin away from the catheter site as described for local infusion of lidocaine, and puncture with a 22-gauge needle; allow the skin to roll back into position over the vein and introduce the catheter via the puncture site. Intraosseous catheterization is an option when intravenous access (standard or cut-down technique) is impossible. The site of entry is prepared, and the bone cavity entered with a spinal needle of larger injection gauge, 22 to 18. The catheter is secured with tape and fitted with an injection port. Placement is facilitated with sedation and local analgesia, in the form of topical lidocaine, and lidocaine injected under the skin and into the periosteum at the entry site.[13]

Decision 3

When should diagnostic workup proceed?

In the stable patient, diagnostic workup can proceed when practical. The authors have found that ill, sedated patients often tolerate diagnostic imaging and venipuncture for diagnostic sampling without additional anesthesia, which should be avoided. In many cases, workup can proceed immediately after catheterization. For those patients where clinical judgment indicates struggling and resistance to handling may carry increased risk, but speedy diagnostic workup is indicated, consider a slight increase in dosage of midazolam/opioid, or the addition of very low dose ketamine (see **Table 1**), or low concentration (2%–3%) isoflurane delivered via face mask.

Decision 4

Can this patient be managed medically or will surgical intervention be required?

Due to frequent uncertainties in exact underlying diagnoses, and complications related to complex gastrointestinal anatomy and physiology, determination of prognosis and selection of ideal therapy can be difficult. As mentioned earlier,

all rabbits with evidence of gastrointestinal disease should receive fluids. Whereas some patients present strongly suggesting the presence of gastrointestinal obstruction or other condition requiring surgical intervention, many presentations are far less certain. In these cases, decision-making relies on response to medical therapy, with progress determined by changes in physical condition and as demonstrated radiographically (see later discussion).

While surgical intervention is generally reported as associated with poor overall prognosis,[11] some investigators have suggested that earlier surgical intervention may improve survival. In an article examining outcomes in 76 cases of gastric dilation and intestinal obstruction, survival rate for rabbits with evidence of intestinal obstruction (dilated stomach, suggestive radiographic findings) undergoing exploratory surgery was 40%.[5]

DIAGNOSTIC WORKUP FOR RABBITS WITH RGIS

Radiography

Radiography remains the single most important diagnostic test for evaluation of the gastrointestinal tract of the rabbit and for monitoring response to therapy.[3] Lichtenberger has found ultrasonographic evidence of hepatitis and pancreatitis in some rabbits with RGIS. In theory, ultrasound may be helpful in identification of obstructions; however, gas accumulation may reduce its value. Blood work is important to help identify underlying abnormalities (anemia, hypoproteinemia) and disease conditions (renal disease), but is nonspecific for gastrointestinal disease.

Radiographs are important for evaluation of location, size, shape and, to some extent, contents of the gastrointestinal tract.[3,5,11] Abdominal radiographs of the normal rabbit are somewhat variable and depend on the current phase of digestion. The stomach is oval-shaped and located caudal to the liver, mostly on the left quadrant. The caudal border does not extend beyond the last rib. There is always some ingesta in the partially filled stomach that is evenly mixed with fine pockets of gas. On the ventrodorsal projection the stomach shape is asymmetric, with the largest curvature on the left side. The stomach is relatively small compared with the rest of the gastrointestinal tract.[3]

The small intestine contains digesta as well, and gas is evenly dispersed. The cecum may be partially to completely filled. When full, the cecum occupies the majority of the abdomen. The distal colon may contain fecal material that takes on the characteristic shape of hard fecal pellets (**Fig. 1**).

Abnormal findings include larger pockets of gas anywhere throughout the gastrointestinal tract, from stomach to colon.[3] An abnormal stomach may begin to take on a more filled to round shape as contents accumulate. There may be impaction of the stomach with accumulation of intestinal gas, or gas accumulation in both stomach and intestine (**Figs. 2** and **3**). The cecum may be impacted, or distended with gas. Rabbits with partial to complete intestinal obstruction may demonstrate typical radiographic findings, including rounded fluid and gas-filled stomach with a gas pattern ending abruptly in the proximal duodenum, or elsewhere. The authors have observed cases of obstruction with gas present both proximal and distal to the site of obstruction, likely a result of obstructive accumulation of gas, and accumulation due to secondary functional ileus. In cases of ingestion of foreign material, radiodense material may appear anywhere along the gastrointestinal tract.

Capello and Lennox describe "gastric repletion," a potentially pathogenic condition of rabbits adapted to inappropriate, low-fiber diets. The stomach appears overfull on radiographs, but there is no abnormal gas, and rabbits in general do not present with

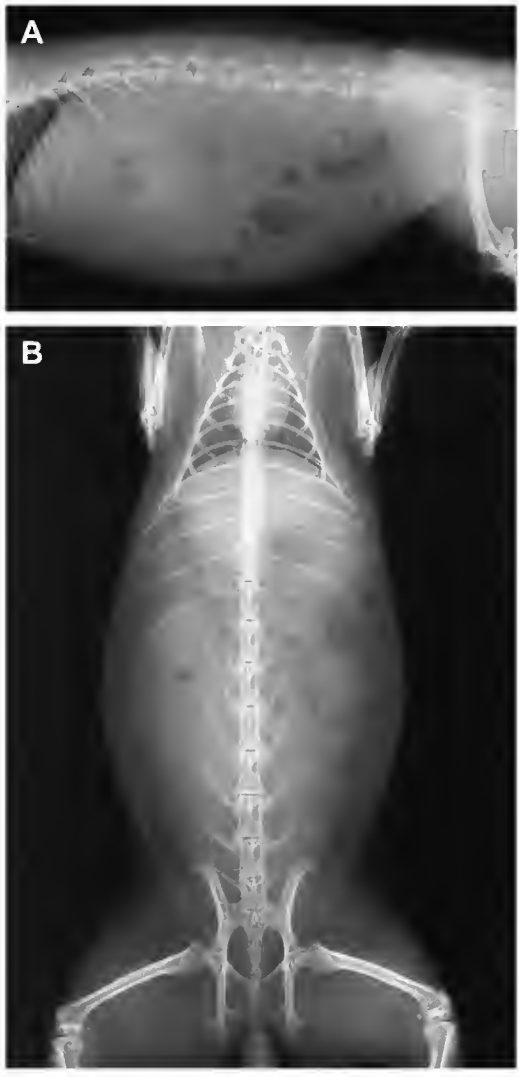

Fig. 1. Lateral (*A*) and ventrodorsal (*B*) radiographs of the abdomen of a normal 1.4-kg intact female rabbit. (*Reprinted from* Capello V, Lennox AM. Clinical radiology of exotic companion mammals. Ames (IA): Wiley-Blackwell; 2008. p. 88–9; with permission.)

symptoms of gastrointestinal disease (**Fig. 4**). The condition is likely related to inadequate dietary fiber. In cases of gastric repletion, the stomach appears overfilled, and extends caudal to the most distal rib. These rabbits are likely at risk for eventual development of gastrointestinal disease.[3]

Radiography is always interpreted along with changes in clinical condition of the patient. Serial radiography is of critical importance for helping to determine response to therapy and changes in therapy (**Boxes 1** and **2**; **Fig. 5**; **Tables 2** and **3**). Radiographs are repeated every 3 to 4 hours in critical patients with evidence of obstructive disease, to as long as every 24 hours in more stable, less severe patients.

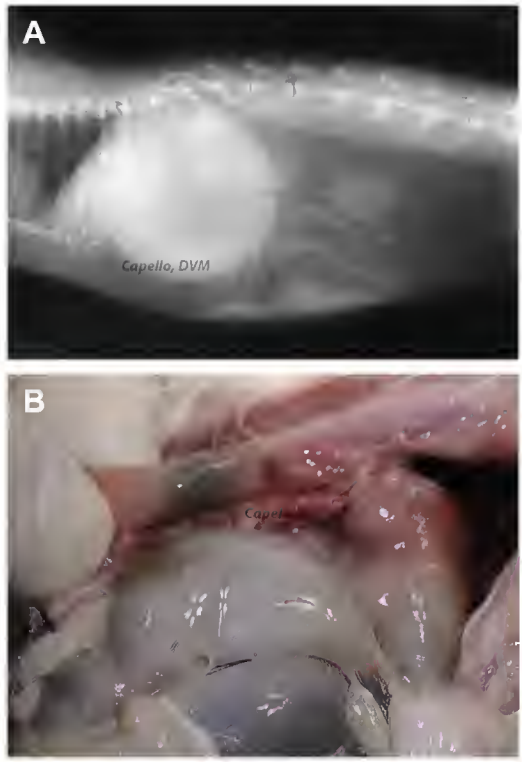

Fig. 2. Lateral radiograph (*A*) and necropsy specimen (*B*) of a rabbit with a duodenal obstruction due to a trichobezoar. Note the overfilled, round stomach with absence of gastrointestinal contents elsewhere along the tract.

Contrast radiography is not commonly described in rabbits, but may be useful, especially in cases of suspected partial or complete obstruction.

Other Diagnostic Testing

Other diagnostic tests (hematology, clinical chemistries, urinalysis) are nonspecific for RGIS or primary gastrointestinal disease, but are useful for evaluation of overall patient condition and as an aid to rule out other underlying conditions.

FLUID ADMINISTRATION FOR RABBITS WITH RGIS

A fluid therapy plan involves the type, quantity, and rate of fluid to be administered. The primary goal is to give the least amount of fluids possible to reach the desired end points of resuscitation. The general principles of fluid administration, including fluid type and rate of administration, are well established in traditional pet species; the authors and others have found these principles practical and efficacious in rabbits as well.

There are 3 phases for fluid resuscitation: correction of perfusion deficits, rehydration, and maintenance.[6,14,15] Fluids used include isotonic crystalloids, colloids, and blood products.[15–17] Isotonic crystalloids (lactated Ringer solution and others) are often used together with colloids in the resuscitation phase.[14,15] Hetastarch (Hospira Inc, Lake Forest, IL, USA) is the most commonly used colloid due to cost and

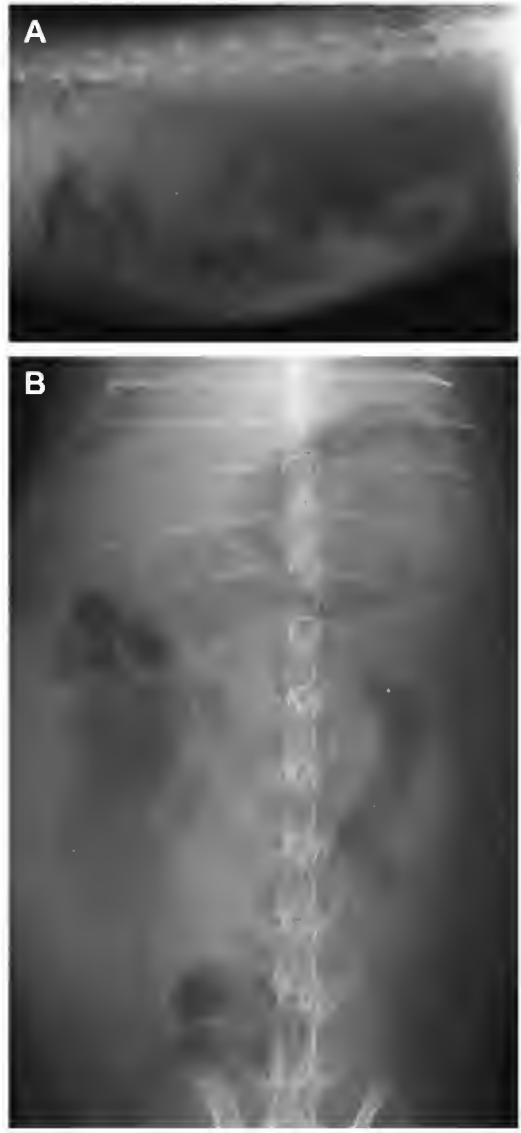

Fig. 3. Lateral (*A*) and ventrodorsal (*B*) radiographs of a rabbit with gastrointestinal stasis as evidenced by gas accumulation throughout the gastrointestinal tract. This rabbit responded well to 24 hours of supportive care, including fluids, hand feeding, analgesia, and motility-enhancing drugs.

availability. Oxyglobin (OPK Biotech, Cambridge, MA, USA) is a colloid with the added advantage of oxygen-carrying ability.

Treatment of Hypovolemic Shock in the Rabbit

Characteristics of hypovolemic shock in the rabbit

According to Lichtenberger, rabbits with hypovolemia commonly present in the decompensatory stage of shock, similar to that commonly seen in the cat

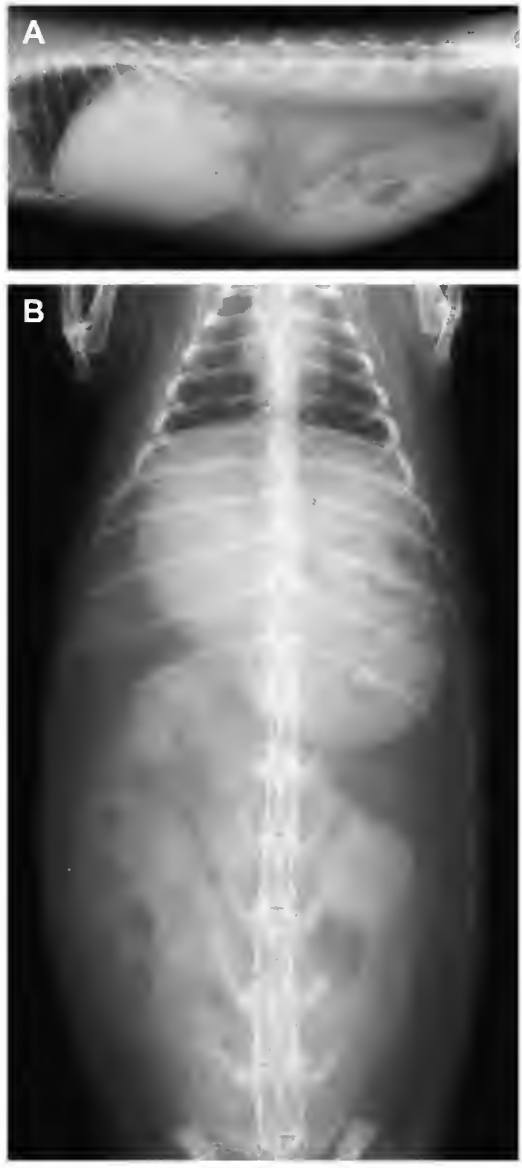

Fig. 4. Lateral (*A*) and ventrodorsal (*B*) radiographs of a rabbit with gastric repletion, or overfilling of the gastrointestinal tract without other evidence of gastrointestinal disease. This finding is common in rabbits on inappropriate diets. In most cases, rabbits are clinically normal but may be at risk for developing gastrointestinal disease in the future. *Reprinted from* Capello V, Lennox AM. Clinical radiology of exotic companion mammals. Ames (IA): Wiley-Blackwell; 2008. p. 106; with permission.

(see **Box 1**). The earlier compensatory stages of shock commonly observed in the dog and bird are generally not seen in rabbits. This difference may be partially explained by the response of rabbit baroreceptors to inadequate arterial stretch in the shock state: sympathetic fiber stimulation occurs concurrently with vagal

Box 1
Correction of perfusion deficits adapted for the rabbit

Decompensatory phase of shock (Bradycardia, hypotension, hypothermia)

- Slow bolus over 10 minutes of hypertonic saline 7.2%/7.5% (3 mL/kg) + Hetastarch (3 mL/kg) IV or IO

↓

- External and core body temperature warming over 1–2 h
- Crystalloids at maintenance (3–4 mL/kg/h)

↓

- When patient is warmed to 98°F (36.7°C), use slow IV/IO fluids (see below) to correct indirect systolic blood pressure to >90 mm Hg (after each bolus recheck blood pressure-repeat bolus 3–4 times until blood pressure is normal)

  Crystalloids (lactated Ringer solution, normasol, Plasmalyte) at 15 mL/kg

  Hetastarch at 3–5 mL/kg

↓

Unresponsive shock to above protocol:

- Consider oxyglobin at 2 mL/kg slow bolus, and if systolic blood pressure is >90 mm Hg:

  Start crystalloid constant rate infusion (CRI) to correct dehydration or if not dehydrated then at maintenance (3–4 mL/kg/h)

  Start oxyglobin CRI at 0.2 mL/kg/h

- If the patient continues to be unresponsive:

  Check blood glucose, blood urea nitrogen, acid base, and electrolytes—correct if abnormal

  Check packed cell volume (PCV) and total protein; consider whole blood transfusion if PCV is <20 (see blood transfusion in text)

  Check echocardiogram for abnormal heart function and correct contractility if abnormal

  Recheck temperature of patient and warm again if hypothermic

- If the patient continues to be unresponsive and systolic blood pressure is <90 mm Hg (but patient is normothermic):

  Consider vasopressors in the doses recommended for small animals (ie, norepinephrine, dopamine)

fiber stimulation, resulting in normal to slow heart rate. This finding contrasts with those in dogs under similar conditions whereby fiber stimulation results in tachycardia.[14,15]

Many rabbits with clinical evidence of shock demonstrate bradycardia (<180 beats/min), hypotension (systolic blood pressure <90 mm Hg), and hypothermia (temperature lower than 97°F [36.1°C]).

Treatment of hypovolemic shock

Earlier recommendations for the treatment of hypovolemic shock included rapid administration of crystalloids administered in volumes equivalent to several times the patient's blood volume. However, rapid resuscitation with crystalloids alone can result in significant pulmonary and pleural fluid accumulation. Newer

Box 2
Estimation of dehydration deficits and calculation of fluid replacement needs for the rabbit

Estimation of percentage dehydration:

>10% = dry mucous membranes, suction eyes, altered mentation, very significant skin tenting

7%–9% = dry mucous membranes, skin tenting

5%–7% = dry mucous membranes and mild skin tenting

4%–5% = dry mucous membrane

Fluid requirements of dehydration deficits calculation:

%dehydration × kg × 1000 mL/L = fluid deficit (L)

This amount is added to maintenance requirements (3–4 mL/kg/h) + any losses (ie, diarrhea)

Replacement over how many hours based on how fast the losses occurred:

Losses occurred in <24 h = acute so replace dehydration deficit over 6–8 h

Losses occurred over 24–72 h = chronic, so replace over 24 h

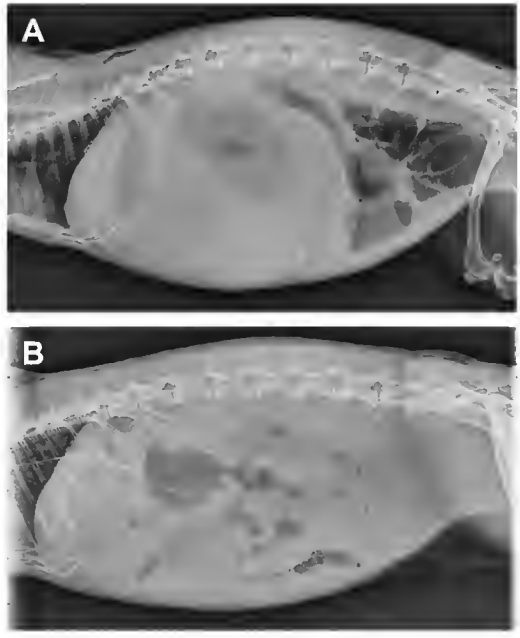

Fig. 5. Changes in clinical condition, and changes noted radiographically are used to determine response to therapy, and determine if changes in therapy are indicated. In this case, foreign body obstruction was listed in the differential diagnosis based on extreme distention of the stomach (*A*). However, radiographs taken after 12 hours of intensive supportive measures, including intravenous fluid therapy, indicated medical management was effective (*B*). This rabbit was discharged 24 hours later. Note the presence of a nasogastric tube for support feeding in (*B*).

Table 2
Radiographic findings associated with improving or declining condition in rabbits with suspected gastrointestinal disease

Improving Condition	Declining Condition
Reduction of the size of individual gas accumulations	Increasing gas accumulations
Changes in gas accumulation pattern-gas has moved or appears to have "broken up"	Specific areas of gas accumulation unchanged
Presence of formed stool in the distal colon	
Decrease rounded appearance of the stomach	Stomach size increasing, shape more rounded

Findings must be interpreted in conjunction with changes in the patient's overall clinical condition.

recommendations include a combination of crystalloids, colloids, and rewarming procedures.[14,15]

Begin with a bolus infusion of 7.2%–7.5% hypertonic saline (3 mL/kg as a slow bolus over 10 minutes) to rapidly draw fluid from body compartments into the intravascular space.[16] The effect is maintained with the addition of Hetastarch administered at 3 mL/kg intravenously or intraosseously over 5 to 10 minutes. Blood pressure is monitored; once it is above 40 mm Hg systolic, maintenance volumes of isotonic crystalloids are administered, while the patient is aggressively warmed (**Fig. 6**). Warming and restoration of normothermia should ideally be accomplished within 1 to 2 hours using both external techniques and core temperature warming via administration of warm intravenous fluids. Fluids are warmed with intravenous fluid warmers or by running the intravenous fluid line through a pan of hot water. In many cases, once rectal temperature approaches 98°F (36.6°C), adrenergic receptors can begin to respond to catecholamines and fluid therapy, and blood pressure will increase. At this point, boluses of isotonic crystalloids (10 mL/kg) with Hetastarch (5 mL/kg) can be repeated over 15 minutes until the systolic blood pressure rises above 90 mm Hg. When the systolic blood pressure is greater than 90 mm Hg, the rehydration phase of fluid resuscitation begins (see **Box 1**).

Table 3
Physical examination findings associated with improving or declining condition in rabbits with suspected gastrointestinal disease

Improving Condition	Declining Condition
Eating on own Taking hand feeding well	Not eating on own Refusing hand feeding
Appearance of formed stool	Decreasing to absent stool
Resolution of fluid deficits (hypovolemia, dehydration)	No resolution of fluid deficits
Normal posture, grooming activities noted	Continued abnormal, painful posture
Reduction in gas accumulation as detected via palpation or percussion	Gas accumulation as detected via palpation or percussion increasing or unchanged

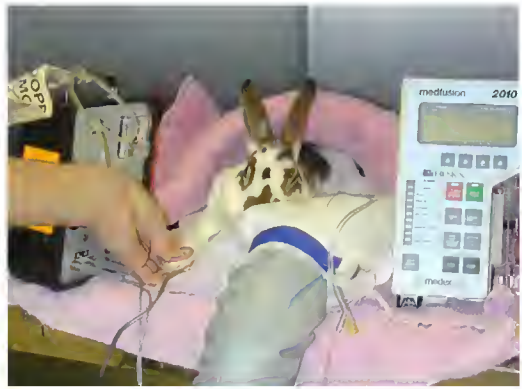

Fig. 6. Indirect Doppler blood pressure can be used to help guide fluid resuscitation for hypovolemic shock in the rabbit. The blood pressure is assessed on the forelimb. Fluids are given until the indirect systolic blood pressure is greater than 90 mm Hg.

Treatment of nonresponsive shock

If end-point parameters (normal blood pressure, heart rate, mucous membrane color, and capillary refill time) are still not obtained after 3 to 4 boluses of Hetastarch and crystalloids, the patient is evaluated and treated for causes of nonresponsive shock (ie, excessive vasodilation or vasoconstriction, anemia, hypoglycemia, electrolyte imbalances, acid-base disorder, cardiac dysfunction, hypoxemia).[14,15]

If PCV suggests marked anemia (<20%), consider whole blood transfusion. Alternatively, administer oxyglobin, at 2 mL/kg boluses over 10 to 15 minutes until restoration of normal heart rate and blood pressure (systolic blood pressure >90 mm Hg); this can be followed by a CRI of oxyglobin at 0.2 to 0.4 mL/kg/h.

Hypoglycemia is treated with an initial bolus of 50% dextrose at 0.25 mL/kg as a 1:1 dilution with saline. Parenteral use of dextrose should be conservative, as it may induce compartmental shifts in electrolytes and water, which could ultimately lead to further hypovolemia. Blood glucose is determined 1 hour later. If hypoglycemia persists, continue CRI of low-concentration dextrose, for example, 1.25% dextrose in crystalloids, while rechecking blood glucose every 2 to 3 hours.

SPECIFIC THERAPY FOR TREATMENT OF DEHYDRATION AND CALCULATION OF MAINTENANCE FLUIDS

The percentage of dehydration can be subjectively estimated based on body weight, mucous membrane dryness, decreased skin turgor, sunken eyes, and altered mentation (see **Box 2**).[6,14] As mentioned above, dehydration deficits greater than 5% ideally require intravenous fluid replacement using a constant-rate infusion of a crystalloid fluid. Fluid requirements for dehydration are calculated as:

$$\% \text{ dehydration} \times \text{kg} \times 1000 \text{ mL/L} = \text{fluid deficit (L)}$$

Dehydration requirements should be added to fluids volumes for daily maintenance requirements (3–4 mL/kg/h) and ongoing losses, for example, diarrhea and polyurea. If fluid losses occurred in the last 12 to 24 hours (acute loss), then dehydration deficits are ideally replaced over 6 to 8 hours. If losses occurred over 24 to 72 hours, then dehydration deficits are replaced over 24 hours.[6,14–16]

Whereas urinary catheterization of companion mammals is often used as an objective measurement of urinary output, this is not usually practical in rabbits. Alternatively,

urine output can be subjectively evaluated by periodically comparing the weight of absorbent bedding.

Another objective way to assess whether the fluid volume is adequate is to evaluate body weight regularly throughout the day, as acute weight loss is commonly associated with fluid loss.

If the patient is hypoproteinemic, administer a constant rate infusion (CRI) of Hetastarch at 0.8 mL/kg/h during the rehydration phase, combined with crystalloids at rehydration rates. The addition of Hetastarch helps maintain oncotic pressures in the intravascular space during rehydration therapy.[14–16]

Hydration status should be reevaluated frequently and rates readjusted accordingly. Maintenance fluids are provided until the patient is able to assimilate adequate fluids via eating and drinking.

Nutritional Support

Provision of nutrition should proceed as quickly as possible, and is important for prevention and/or treatment of RGIS.[11] Contraindications of enteral support include suspected partial or complete intestinal obstruction, or stasis whereby the stomach is already full. It must be kept in mind that fluid therapy plays an important role, as the gastrointestinal tract must be hydrated to facilitate motility and function.

In general, rabbits tolerate hand feeding via syringe extremely well. The feeding syringe is placed into the diastema, which is the large space between the incisors and premolars. Syringe feeding must be performed slowly with small volumes to prevent aspiration.

The most suitable enteral diets for syringe feeding in rabbits have a high percentage of nondigestable fiber, low fat, and relatively low carbohydrates. Herbivore enteral diets are commercially available from Oxbow Pet Products (www.oxbowhay.com). The Oxbow products have been specifically formulated for nutritional support of herbivorous small mammals and rodents. The kcal is given on a dry matter basis, with 2.69 kcal per gram of dry weight of the powder. When mixed as directed, Critical Care Enteral powder:water 1:1.5 v/v provides approximately 1.9 kcal/mL.

When syringe feeding is refused or inadequate, and feeding is determined to be appropriate based on patient condition, feeding via nasogastric tube should be considered. Two diets have been designed for use with a nasogastric tube: Critical Care (Oxbow Fine Grind Critical Care) and Emeraid Herbivore Elemental Diet (Lafeber, Chicago, IL, USA). These diets should be fed as recommended by the manufacturer. For placement of the nasogastric tube, use a 3.5F to 8F Argyle tube (Surgivet, Waukesha, WI, USA). Length necessary to reach the stomach is determined by measuring from the tip of the nose to the last rib (see **Fig. 7**). To decrease the risk of esophageal perforation, a stylet should never be used. A local anesthetic (2% lidocaine gel) is placed into the rabbit's nostril. The rabbit must be properly restrained while protecting its back, and the head is ventrally flexed but with the neck straight (to avoid compression of the trachea) by an assistant (see **Fig. 8**). The tube is passed ventrally and medially into the ventral nasal meatus. The end of the tube is advanced until it reaches the stomach. The tube is sutured to the nasal area and on the forehead, between the eyes. The remainder of the tube end is taped around the neck (**Fig. 9**). Verification of placement is determined with a radiograph and/or by aspiration of gastric contents

Regardless of the level of nutritional support selected, food should be available at all times for voluntary consumption. In some cases it is helpful to provide the rabbit with its customary diet served in a familiar bowl. Offering fresh grass, greens, or hay may stimulate appetite.

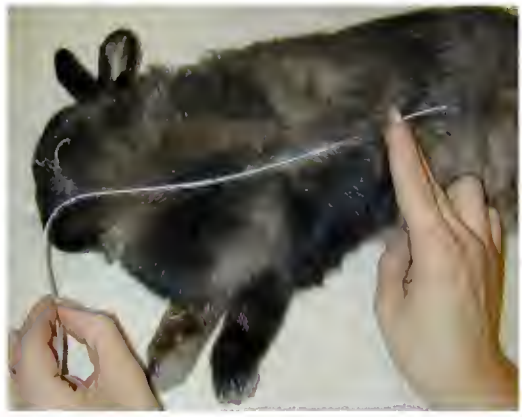

Fig. 7. Nasogastric tubes are placed in rabbits for enteral feeding. The length of tube required is determined by measuring to the last rib of the rabbit.

Promotility Medications and Analgesia

Prokinetics are used frequently, and both scientific and anecdotal reports indicate that these drugs help promote gastrointestinal motility in rabbits.[17,18] Drugs most commonly mentioned include metoclopramide (Baxter Healthcare Corp, Deerfield, IL, USA) and cisapride, or cisapride-like drugs, which are preferred by the authors.

Oral cisapride in rabbits is absorbed rapidly from the gastrointestinal tract, with a plasma half-life similar to that in dogs.[18] Other data show that cisapride may modify the contractile responses of the isolated rabbit intestine to ranitidine, having a potentiating effect up to a certain concentration. The conclusion is that coadministration of the 2 drugs may lead to enhanced motility.[18]

Timebutine is a motility-regulating drug for humans that has been anecdotally reported as extremely useful for use in rabbits with RGIS. There is limited scientific information available on the effects of trimebutine in rabbits.[19] Timebutine is not currently available in the United States, but may be legally imported by veterinarians

Fig. 8. The nasogastric tube is lubricated with lidocaine gel and placed into the nose of the rabbit. The head is flexed slightly, and the tube passed into the ventral nasal cavity, then advanced to the stomach.

Fig. 9. The nasogastric tube is sutured to the nose and top of the head (between the eyes). The remainder of the tube can be coiled and taped around the neck.

in small quantities for personal use. Oral formulations are available in Canada and parts of Europe; an injectable form is available in Italy. Motility-enhancing drugs are contraindicated in cases of suspected gastrointestinal obstruction.[20]

Analgesia is important for rabbits with RGIS. Use of opioids is discussed earlier in the section on sedation. Analgesia can be delivered in bolus doses, or for rabbits with suspected severe gastrointestinal pain in the form of CRI. Drugs commonly used by Lichtenberger are fentanyl and ketamine combined in low doses delivered with crystalloids (see **Table 1**).

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